Wolfgang Metzger: Laws of Seeing

Chapter 5. Gestalt laws serving camouflage

Chapter 10. Yet another important camouflage principle

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Gestalt laws apply not only to human vision, but are also effective in animal vision. Many animals become invisible because their patterns and colors blend perfectly with their environment. This is called *camouflage* and is due to the Gestalt factor of *similarity*.

In Figure 71A, the sea spider carries a tuft of red algae on its back and therefore becomes completely invisible in its natural surroundings (Figure 71B). The algae obliterate the borders that normally outline the body. In Figure 71C, the flatfish cannot be seen because its color is similar to that of the ground. But if the animal starts moving, it immediately pops out from the sandy bottom due to the Gestalt factor of *common fate*. The boundaries of the moving body can be beautifully seen, but will disappear from view shortly after the animal settles on the ground.

In order to be effective, the color of the body and the color of the background need to match. Metzger notes that snow animals are white, grass animals green, and desert animals yellowish or brown. Therefore, an animal is best protected, if it manages to adapt its color as well as pattern to a changing background. Chris Tyler and Rama Ramachandran have demonstrated that a flounder will quickly reproduce on its body the checks of a checkerboard, onto which is placed. A chameleon is similar adept. The physiological mechanism achieving this kind of imitation is a miracle of nature. In Figure 71D the spotted eggs of the bird are perfectly hidden among the pebbles and stones on the beach according to the Gestalt law of *belongingness*.

An important principle of camouflage is *playing dead*. An animal that remains completely motionless will normally not be seen and, if seen, will likely not be eaten. In Figure 76, the snail can hardly be distinguished from the thorns of the twig. Similarly, in Figure 77 the butterfly looks just like another leaf and will probably be overlooked by a hungry bird due the factor of *similarity*. Note the delicate pattern on its wings imitating the ribs and other fine nuances of the leaves. See also Figure 93A with the moth closely resembling the bark of the tree on which it sits.

Although powerful, the effect of the Gestalt factors is relative. A uniformly brown coat on a snowy meadow does not conceal, but rather reveals. That is why

some animals change the color of their fur when winter arrives. Also, in a dynamic environment it does not help much if you play dead. In order to be invisible, an animal would have to move in unison with its surroundings or else it will segregate itself from the environment and become conspicuous. The correct behavior is shown in Figure 79 by the bird swinging with the grasses according to the factor of *common fate*. Neurophysiologists have found that motion contrast is encoded in area V2.

The perception of *biological motion* (Gunnar Johansson) is most remarkable because it entails motion vectors of different direction, size and speed. How the visual system extracts, for example, the percept of two persons dancing with each other from a few faint lights attached to their joints, is not well understood. (It would be nice if further experiments in adults and children were done to define the boundary conditions of this remarkable phenomenon.)

Animals that live in the forest frequently have a dappled fur. This helps them to become inconspicuous to predators in their environment. Similarly, wildly colored jungle birds "disappear" in the colored foliage of a tropical forest. The same principle of dappling is used by the military to conceal heavy artillery. Also, soldiers who wear uniforms with irregular blotches (fatigues) are far better protected. Both have in common that they (i) tear up the uniformity of a surface, (ii) wrongly partition it and (iii) break up the borders through inappropriate continuations. (See examples of "hidden" figures in Chapters 1 and 2)

In Figure 92, the bird's striations could be part of the jumble of twigs in which it hides. Metzger notes that the Gestalt laws are most effective under poor viewing conditions, from a great distance and when the gaze is not directed at the object under consideration. He writes: We are blind to the most familiar things, when their perceived markings are deflected from the actual outlines in accordance with the Laws of Seeing.

A powerful factor for camouflage is *good continuation*. This is shown in Figure 94 where the caterpillar looks like the umbels to the left and right because of its shape and orientation. Here the body structure has become adapted to the shape of the host plant in the interest of camouflage. Another striking example is shown in Figure 95 by the spiders whose slender bodies mimic the shape of the plants on which they dwell.

Camouflage depends not only on the environment, but also on the lighting. When the illumination is inappropriate, the animal will likely be seen. This is demonstrated in Figure 153, where the hen stands out perceptually from the background despite the similarity in texture. The reason for this failure of camouflage is the distribution of light. It not only produces a bright line on the back and a shadow under the belly, but also a distinct roundness, thereby delineating the body from the surround. The same brightness difference between back and belly, in addition to the dark shadow on the

ground, makes the bird in Figure 154 clearly visible despite its white feathers. For this bird, diffuse illumination (Figure 105) as in fog would be a blessing.

Position also plays a role in hiding. The white hare in Figure 155 when seen from the side stands out starkly against the dark background, but will easily blend with the snow when seen from above. Thus, a high-flying raptor may not see it, but a ground-dwelling fox will. The influence of lighting is illustrated by Thayer's law according to which differences in coloration and illumination will tend to cancel each other, so-called *counter-shading*. Figure 157(a) shows a vertical gradient from dark to bright as is frequently found on the body of animals (e.g., mammals, fish), while Figure 157(b) shows the opposite gradient, corresponding to the distribution of light coming from above. The combination of (a) and (b) results in a uniform surface with no volumetric cues that makes the animal appear flat and more difficult to see.

Animals with dark backs usually sit with their back to the light, because this is the best position for successful camouflage. If you turn them around they promptly attempt to assume their original position (see Figure 168). To be able to do so, they must sense the direction of the incoming light. Indeed, animals such as caterpillars have been found to have photo sensors distributed over their entire body.

The finding that the same Gestalt laws that are effective for human observers also serve this purpose in the animal kingdom was taken by Metzger as evidence that Gestalt laws are universal. It also implies that the same or similar neuronal mechanisms must underlie vision and visual perception in the different species. It finally suggests that these mechanisms are "hardwired" to ensure survival and that, for this reason, they may be considered innate.

What is remarkable and frequently overlooked is that species ranging low in the phylogenetic chain of evolution exhibit perceptual behavior similar to ours although their nervous system is miniscule in comparison. For example, goldfish and bees behave as though they can see illusory contours and brightness enhancement in the Kanizsa triangle, dispelling any notion of a cognitive origin of these illusions by occlusion and completion. Such species also show evidence of being able to respond to biological motion. Our brain is much larger, more complex, and endows us with a vastly increased plasticity as the basis for intelligent learning, freedom and responsibility. However, our visual percepts probably share a good deal of similarity with those of our lesser relatives.

Examples for the presence of Gestalt vision can be found easily in nature if only you keep your eyes and minds open. Students may like to look up the famous book by Thayer & Thayer (1902?) on camouflage. They may also want to consult a website called "*Deceptions and Illusions: Five Centuries of Trompe l'Oeil Painting*" Exhibition in the National Gallery of Art http://www.nga.gov/exhib